

# Topic 14

## Subsumption Architecture

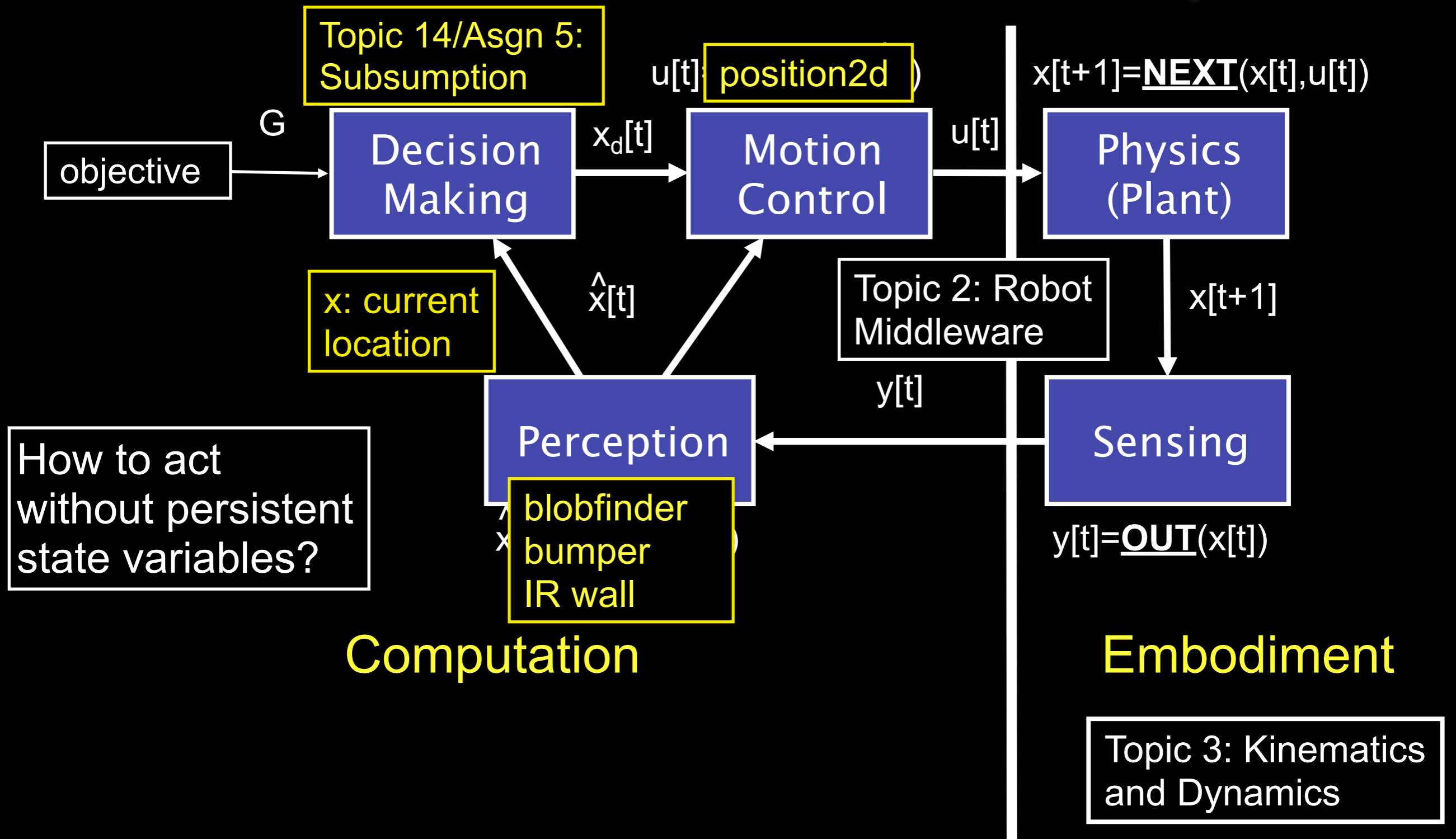


Embodiment  
+ Reaction  
Behavior

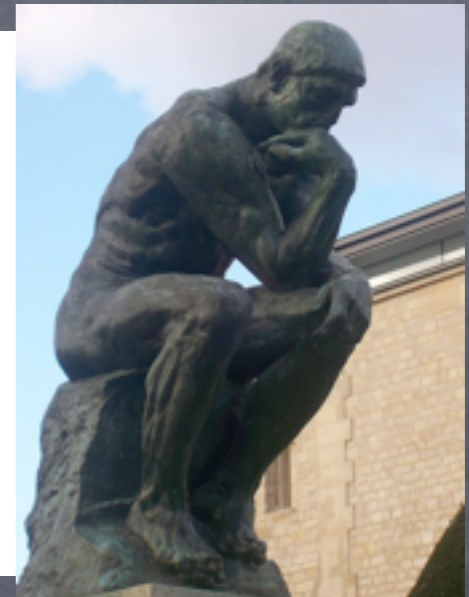
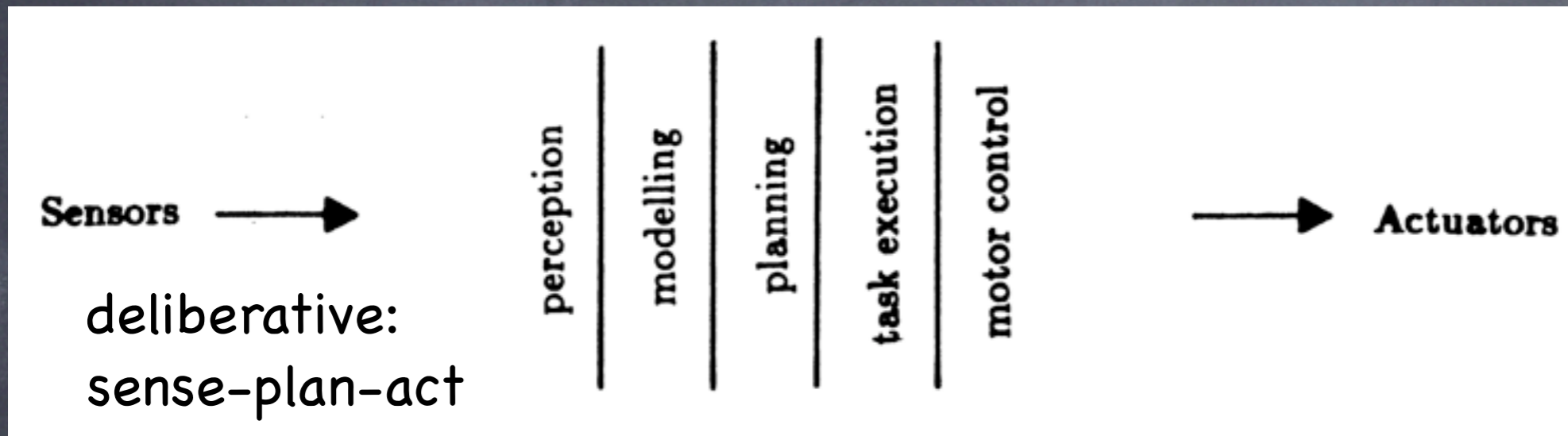
# robot control loop

- someone please sketch on the board

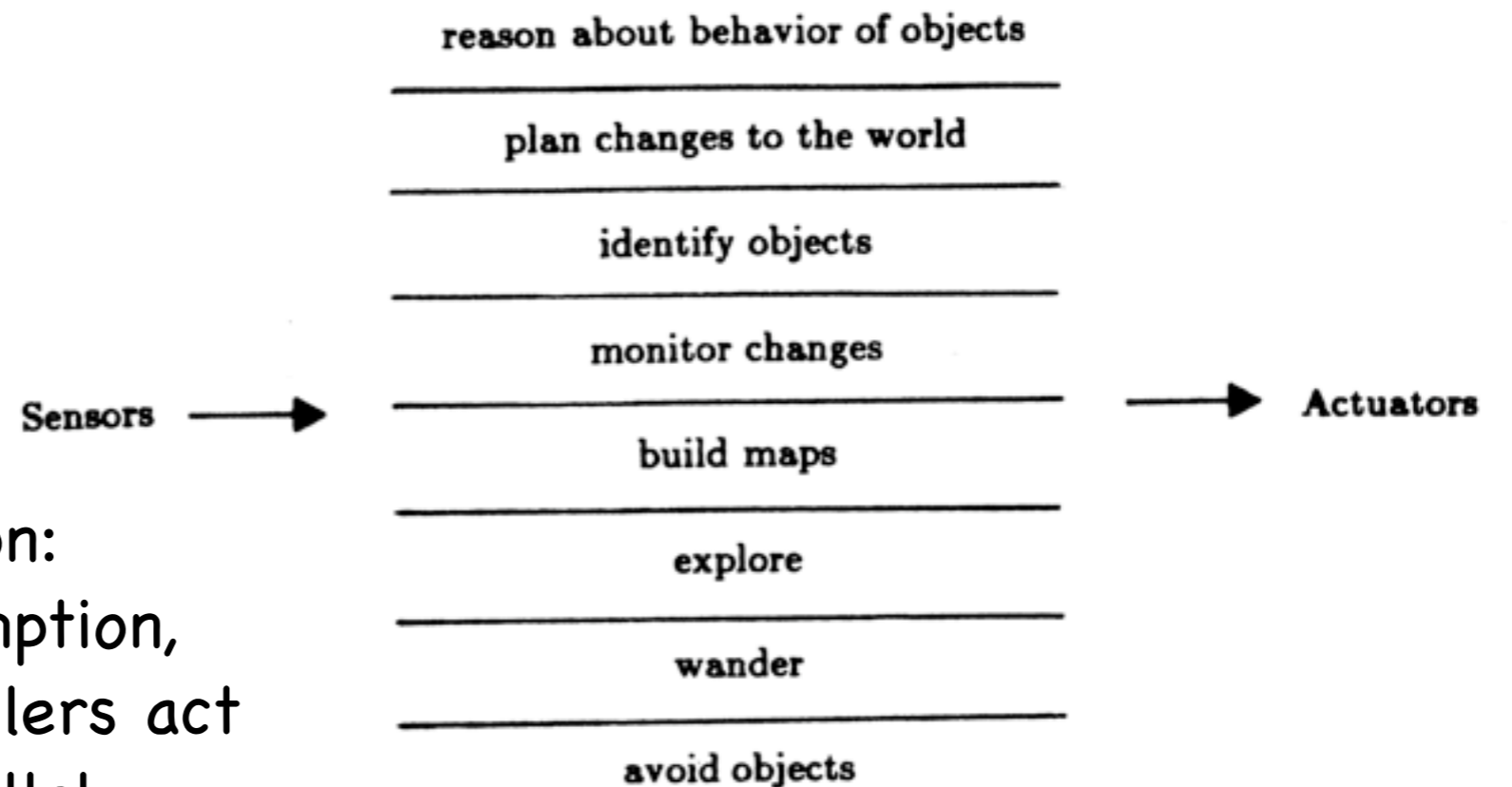
# The Robot Control Loop



# Deliberation v. Reaction



reaction:  
subsumption,  
controllers act  
in parallel

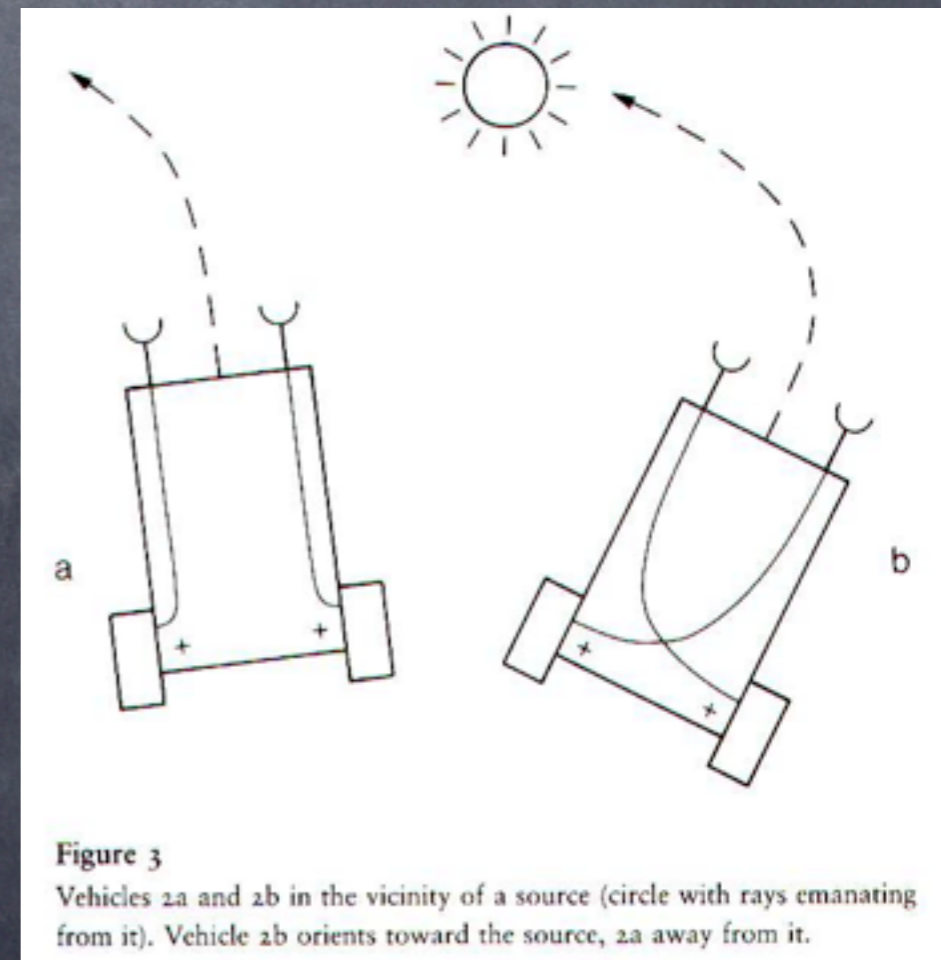


# Embodied Intelligence

Tiny Braitenberg Vehicle  
<http://vimeo.com/5664333>



- Do we need to model the world or build sophisticated controllers?
- Embodied intelligence: robot behavior results from embodiment acting in environment
- Braitenberg vehicle

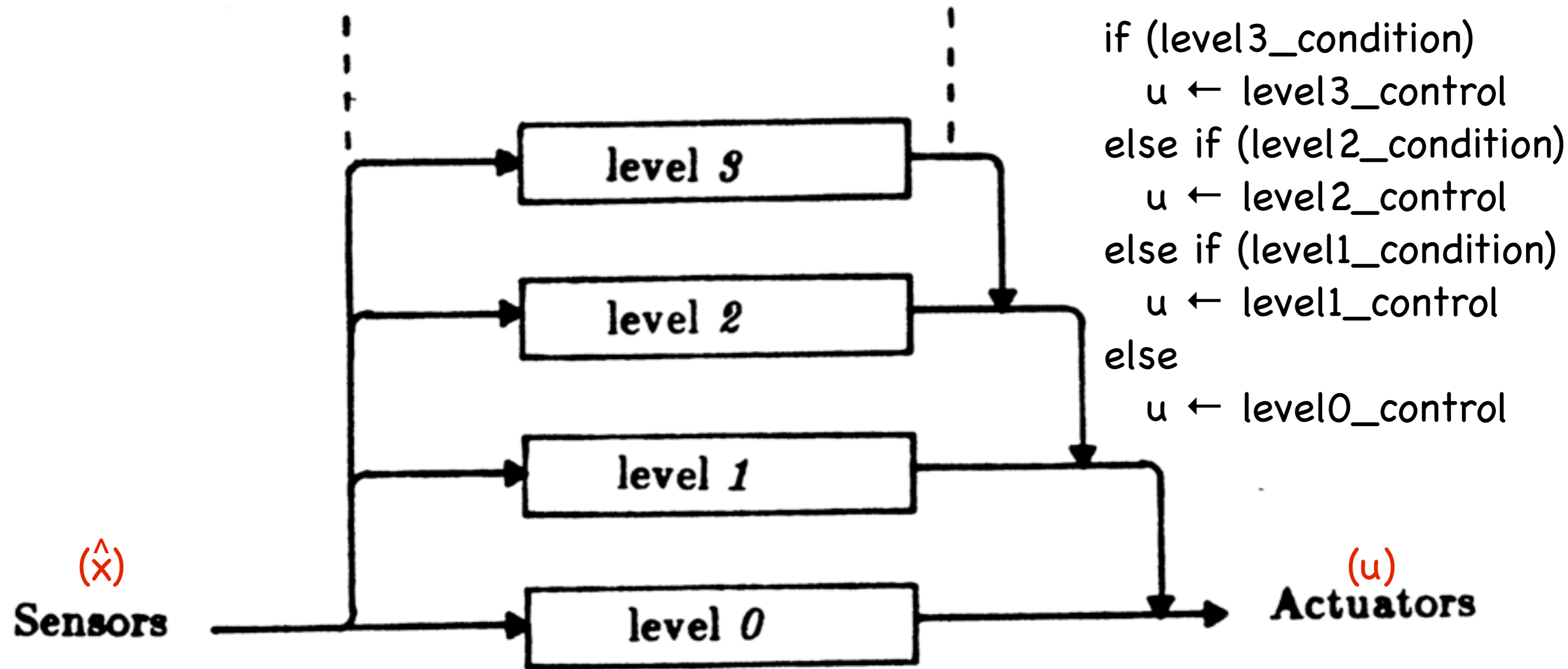


# Ghengis hexapod



# Subsumption Architecture

- Collection of modular reactive controllers in a priority hierarchy
- Controllers can be FSMs
- “Large nested if-else statement”

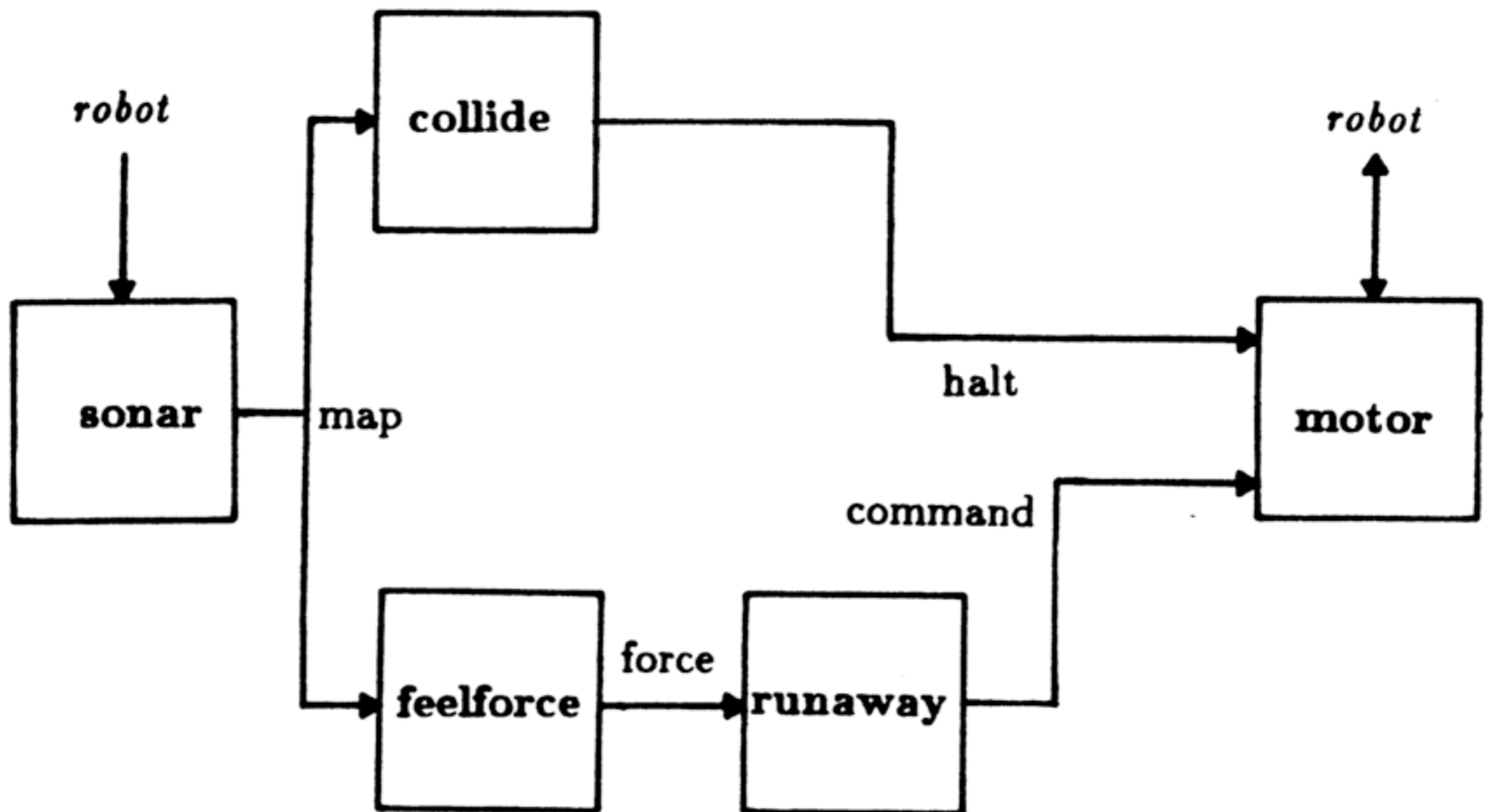


# What modules?

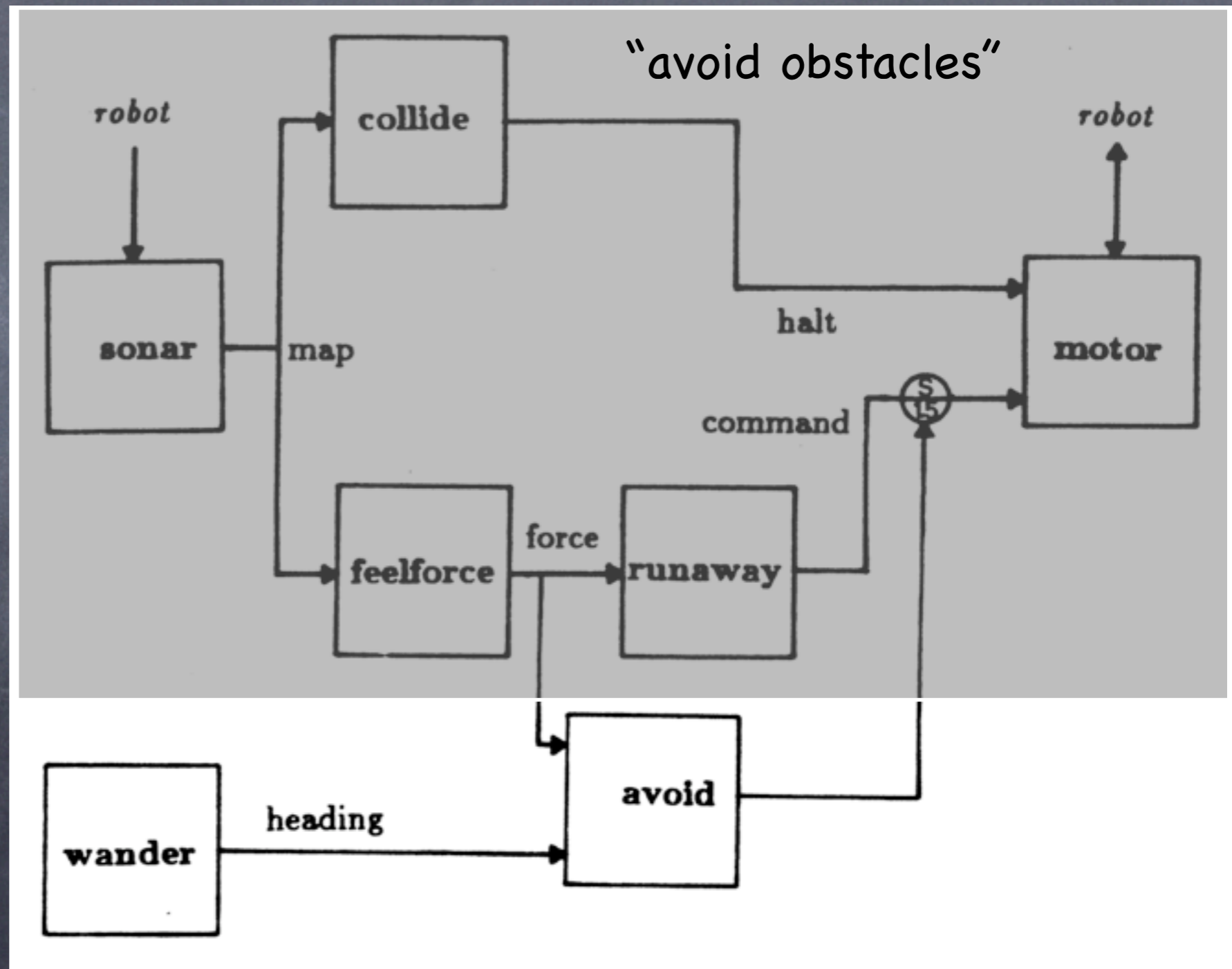
## Subsumption Design Process

1. **Divide your problem into basic competencies** ordered simple to more complex. Designate a level for each basic competency.
2. Further **subdivide each level into multiple simple components** which interact through shared variables. Limit the sharing of variables among levels to avoid incomprehensible code.
3. **Implement each module as a separate light-weight thread.** You might think of setting the priorities for these threads so that modules in a given level have the same priority.
4. **Implement** suppression and inhibition as one or more separate **"arbitration" processes** that serve to control access to shared variables. You might want to control access using semaphores.

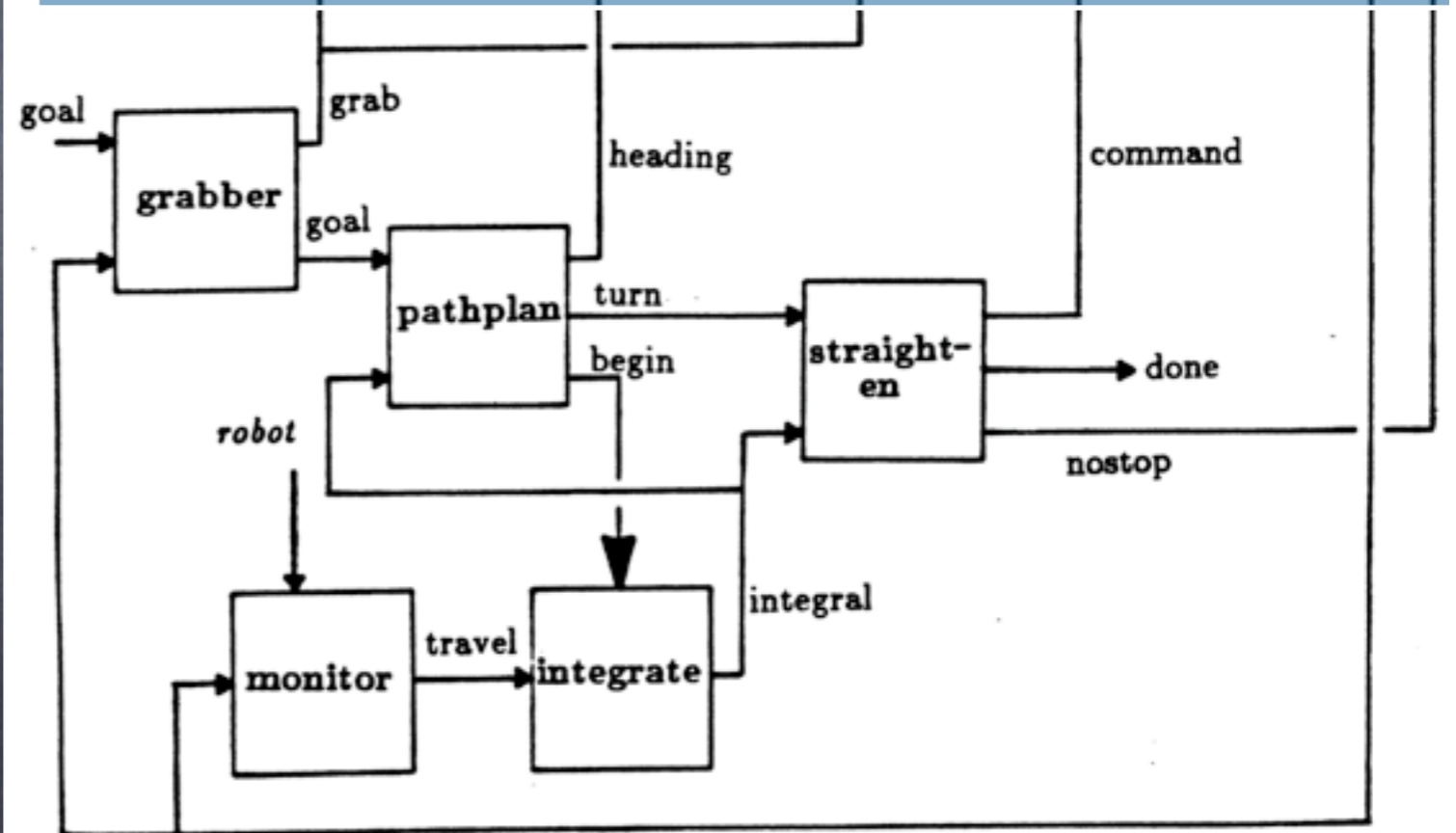
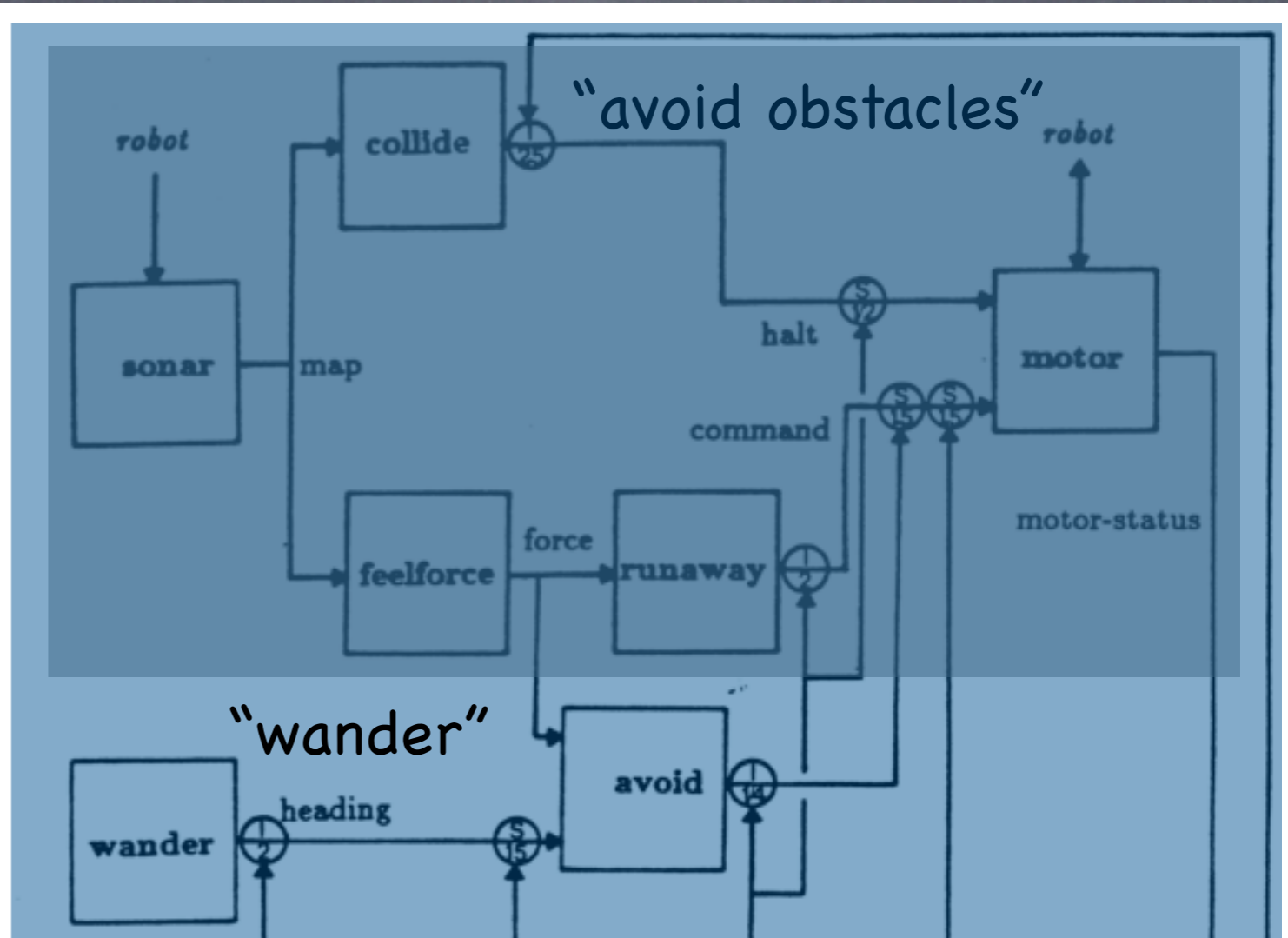
# What is this?



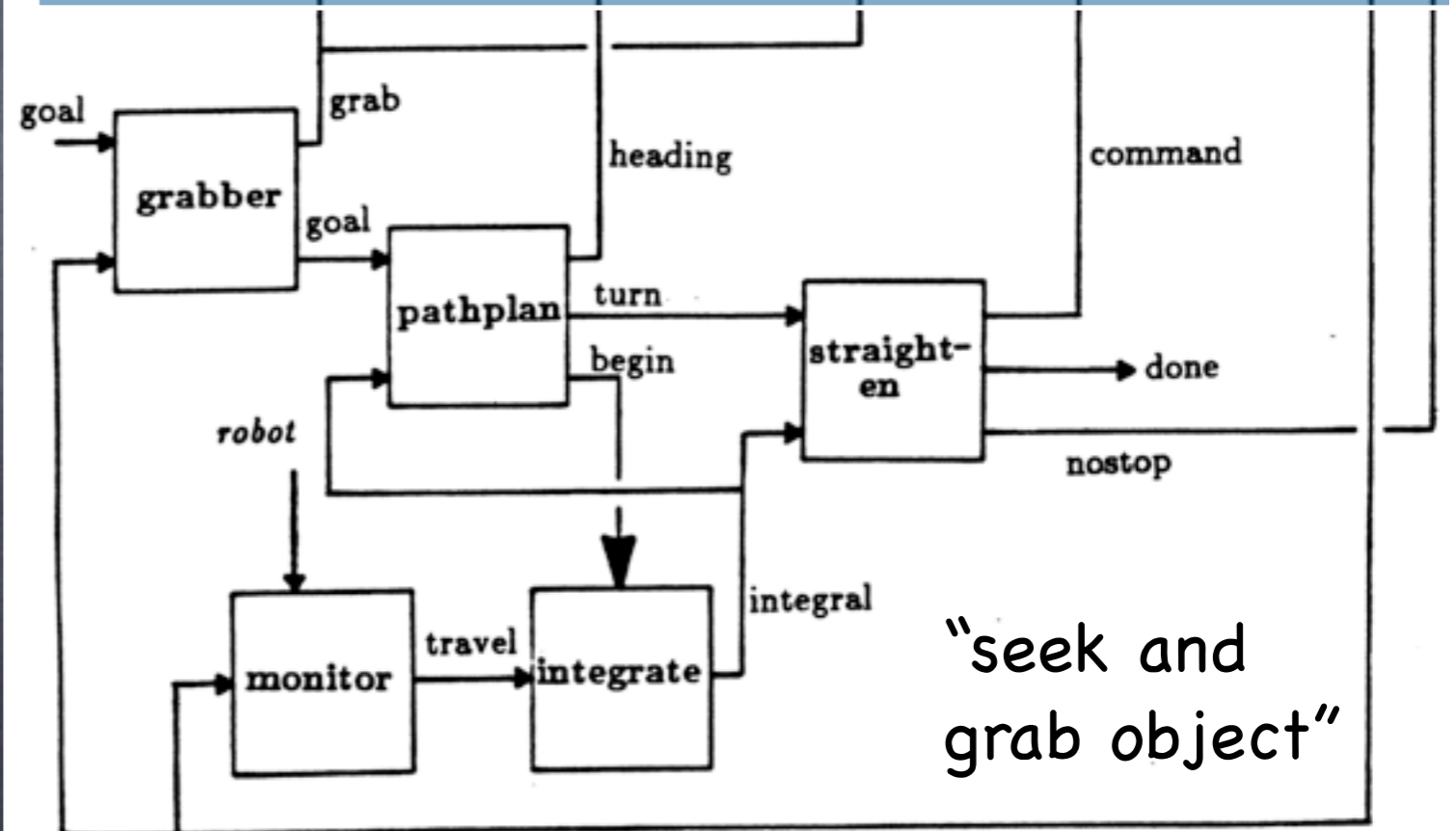
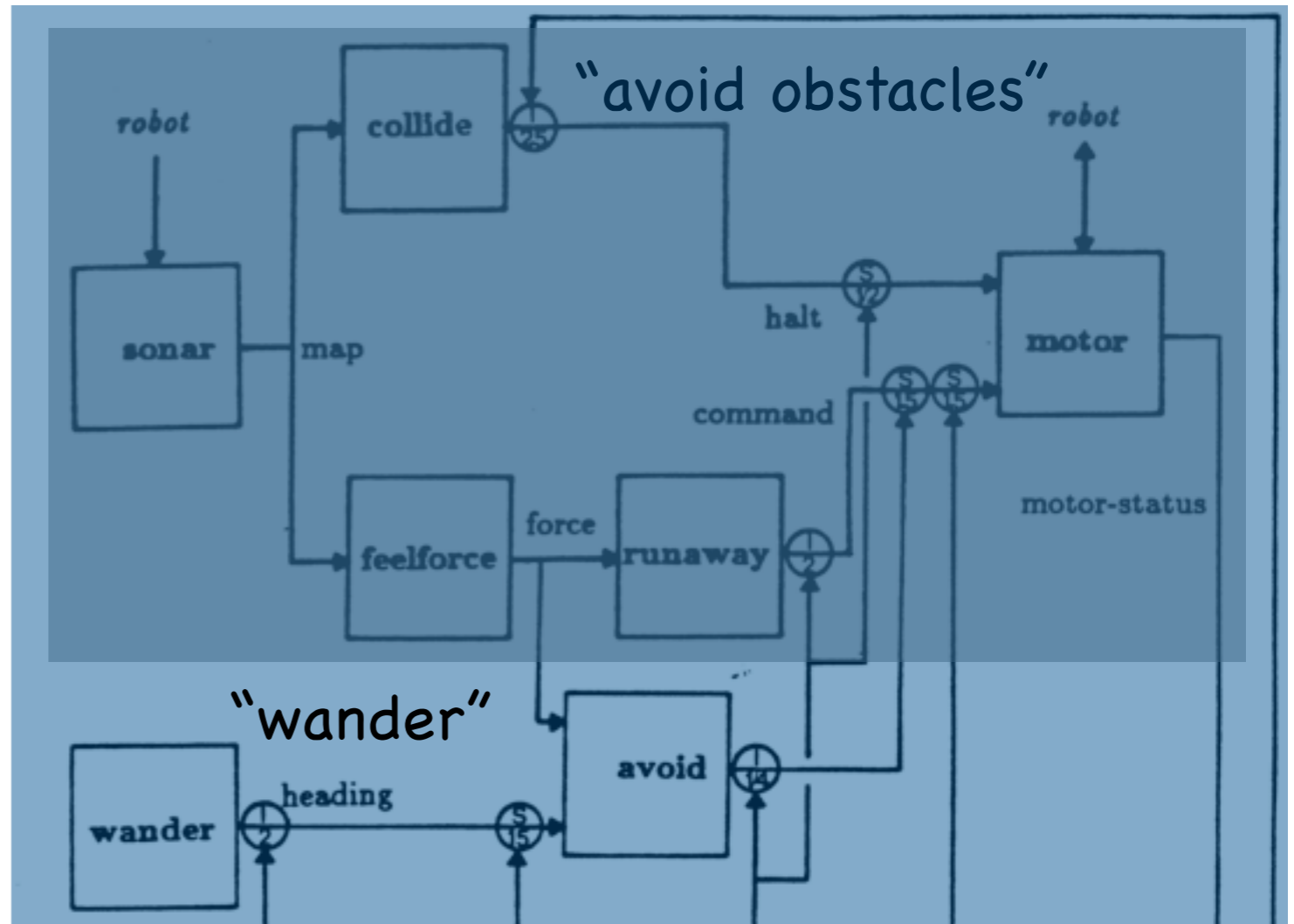
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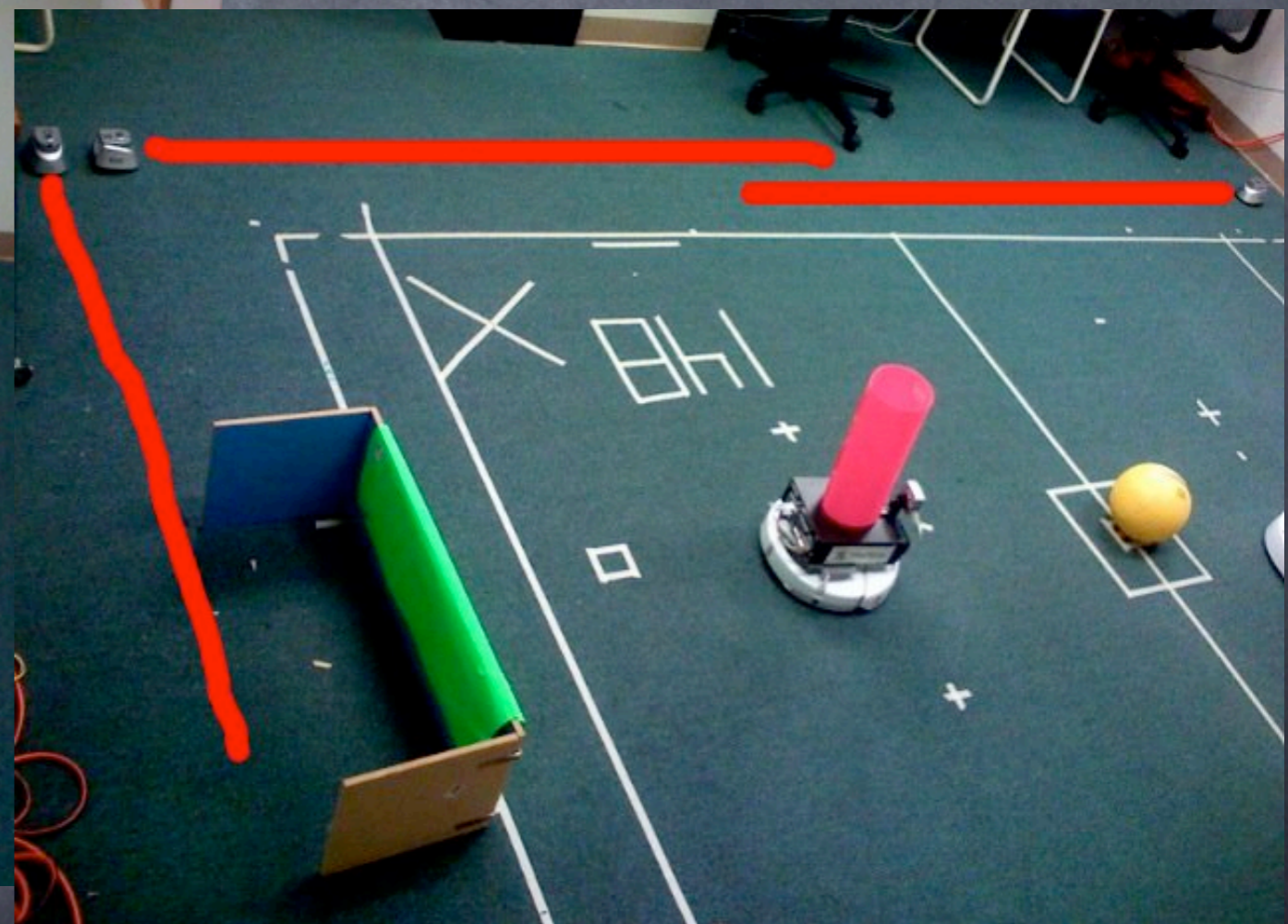
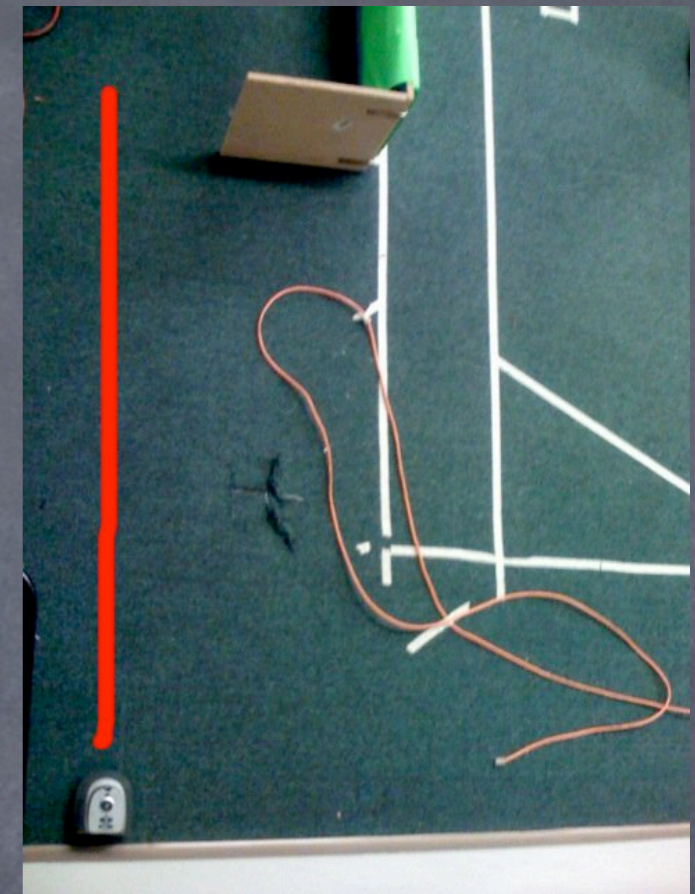
# What is this?



# Assignment 5

## Subsumption for robot soccer

- Propose modules and priority?



# Snappy's Subsumption



Goal Scoring Challenge

1. Avoid IR Wall
2. Avoid Robot
3. Avoid Fiducial
4. Bumper Hit
5. Go To Opposite Goal
6. Go To Any Goal
7. Line Up On Ball
8. Go To Ball
9. Score Goal
10. At Ball
11. Look For Ball

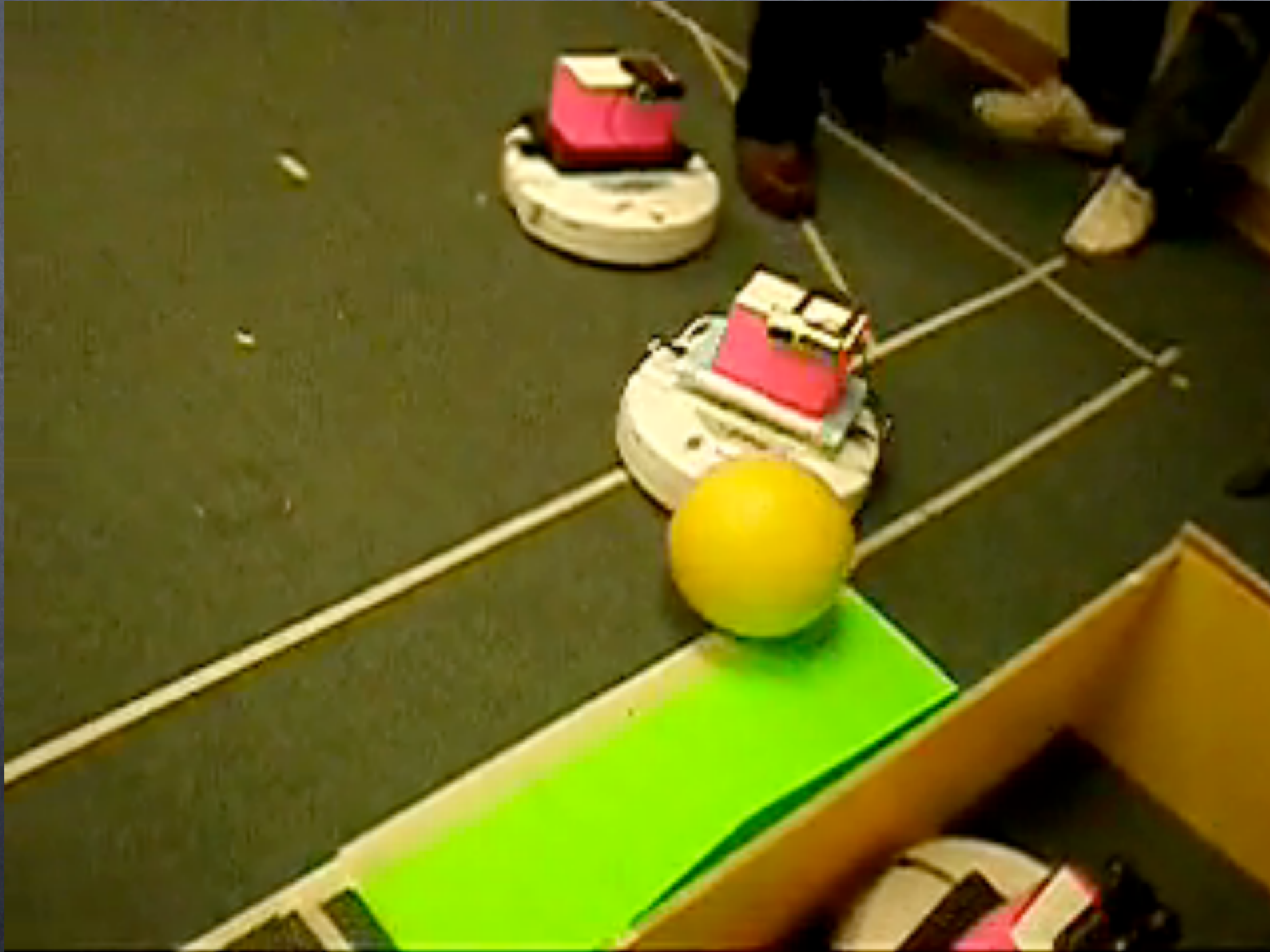
# Snappy's Subsumption



Navigation Challenge

1. Avoid IR Wall
2. Avoid Robot
3. Avoid Fiducial
4. Bumper Hit
5. Go To Opposite Goal
6. Go To Any Goal
7. Line Up On Ball
8. Go To Ball
9. Score Goal
10. At Ball
11. Look For Ball

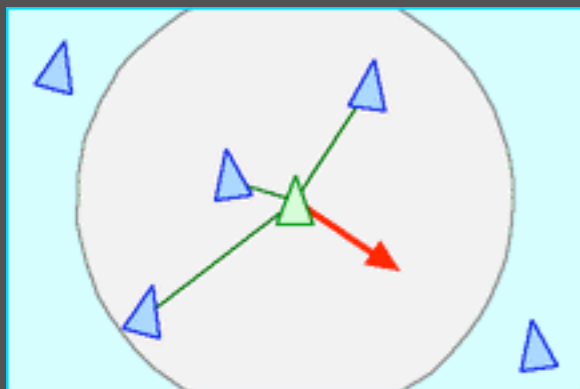
# Snappy in competition



# Swarm Intelligence

- collective behavior of decentralized, self-organized systems, natural or artificial
- complex group behavior emerges from simple local controllers
- Reynolds' Boids for flocking

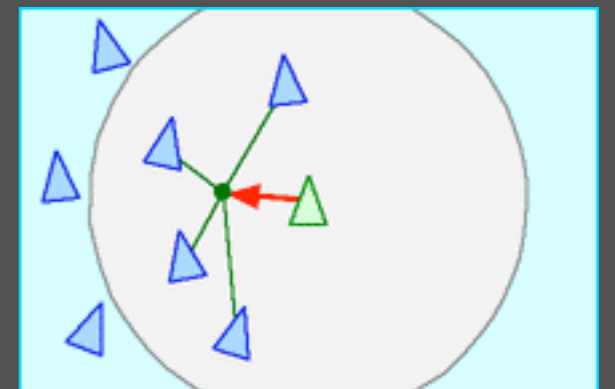
**Separation:** steer to avoid crowding local flockmates



**Alignment:** steer towards the average heading of local flockmates

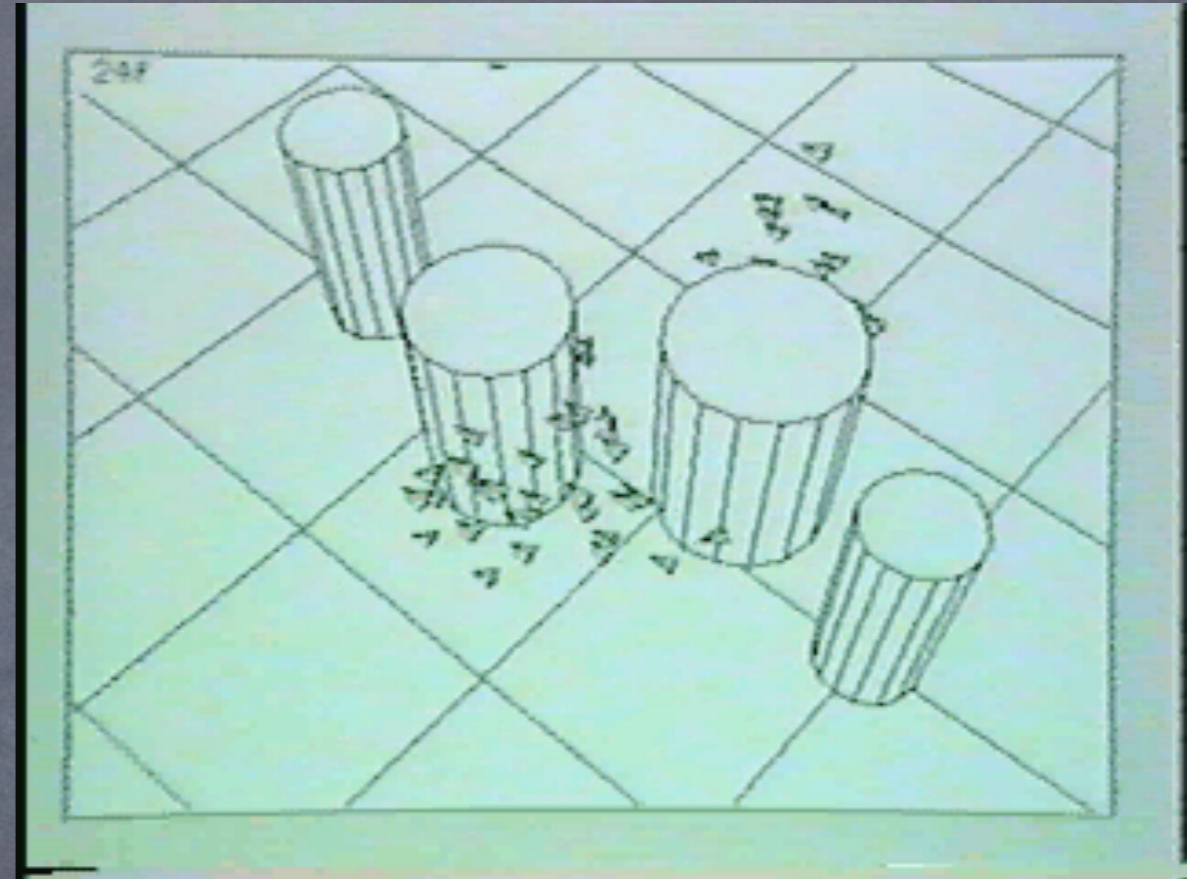


**Cohesion:** steer to move toward the average position of local flockmates

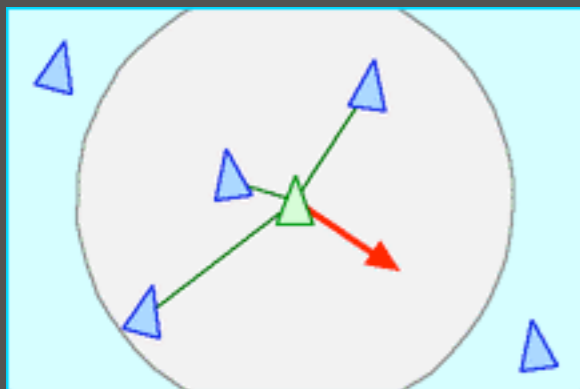


# Swarm Intelligence

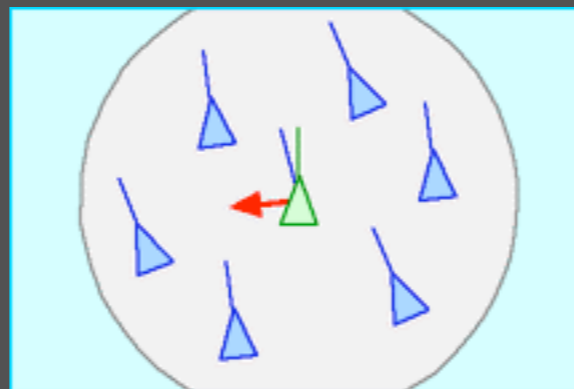
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- Reynolds' Boids for flocking



**Separation:** steer to avoid crowding local flockmates



**Alignment:** steer towards the average heading of local flockmates



**Cohesion:** steer to move toward the average position of local flockmates

